4.5 HYDROLOGIC INTERCONNECTIONS

The primary reason that reduction of recoverable losses does not generate a water supply for reallocation is because of the complex hydrologic interconnections that occur between surface water, groundwater, stream flows, and losses associated with irrigation. Figure 4-7 illustrates a generic "existing condition" for some areas of the Central Valley. Figures 4-7 and 4-8 are used as the basis for a discussion regarding hydrologic interconnections.

In general, if efficiency is improved, indirect use of "losses" by subsequent users will decline, but direct use of water by those subsequent users will increase. Therefore, the basin's hydrology remains relatively stable. To most simply present this principle on the accompanying figures, the following is assumed:

- Crop ET is assumed not to change (no crop modifications or land fallowing), although potential may exist to reduce nonproductive evaporative losses that are inherently included in ET calculations (see later sidebar discussion on evaporation and transpiration).
- Cumulative target flows downstream remain constant for a given period of time (February through September cumulative demands do not change regardless of upstream activities).
- Long-term groundwater levels remain in balanced conditions.

These assumptions are reasonable, especially for basins such as the Sacramento Valley and agricultural areas along the eastern side of the Central Valley. For example, it is quite likely that growers could improve on-farm efficiency but not change the types of crops grown. In addition, seasonal downstream demands usually remain fairly constant regardless of what occurs upstream since these demands are driven by Delta outflow and export demands. Also, groundwater and surface water interaction is governed by rules of hydrology. **When groundwater elevations are lower than river elevation, a river typically will recharge groundwater, referred to as "river depletion." Conversely, groundwater will add to a river's flow when it is higher than the river elevation ("river accretion").**

The interaction between groundwater and surface water, however, can be slow, depending on the local geologic and hydrologic conditions. Delays of days, weeks, months or even years can erroneously be interpreted as water savings when, in fact, none occurred. If the false savings are redirected out of a basin, overdraft of the groundwater resources and loss of in-stream flows can result. In areas that are not experiencing overdraft, the natural process of depletion and accretion usually can maintain a relative balance.

For illustration purposes, this balance is assumed to occur in the same season, although multi-year benefits could sometimes be gained (through conjunctive use projects) but possibly at the risk of reducing water supplies for other purposes, including high winter flows flowing out to the sea or dropping water levels for local groundwater users. (This is when the concept of "time-value" of water, expressed in the Ecosystem Restoration Program Plan, becomes an important factor to consider.)

As shown on Figure 4-7, releases are made from a reservoir to meet local diversions, in-stream uses, and downstream target demands. The fields in the area obtain water for crop needs by various methods, including delivery via a canal diversion, direct river diversion, direct diversion from drainage, and groundwater pumping. As illustrated with the various flow arrows and accompanying quantities (units are not necessary for this example but could be assumed as TAF), "losses" resulting from over-application of water go to surface runoff or deep percolation. In addition to natural recharge, the deep percolation acts to recharge the aquifer. Surface runoff returns directly to the river, to the river via a drainage course, or to another field. A simple water accounting is shown along the river as diversions remove water and surface runoff returns water. In this example, a balance between deep percolation and groundwater pumping creates a slight surplus of deep percolation. It is assumed that this additional groundwater actually results in river accretion (groundwater naturally flowing back into the river) by the end of this hypothetical stream reach.

By contrast, Figure 4-8 assumes that on-farm efficiency improvements are implemented, resulting in decreased river diversions. Crop demands do not change. The reduced diversions could be interpreted as "real" water savings. However, reduced diversions really are the result of decreased deep percolation and decreased surface runoff—water that was being indirectly used for other existing beneficial uses. To continue to meet crop needs, fields that depended on surface runoff for their supplies now have added new wells. The result is that indirect reuse that was occurring in Figure 4-7 from surface runoff and deep percolation now occurs through increased direct groundwater pumping.

Increased pumping, coupled with decreased deep percolation, results in lower groundwater levels. When this happens, the river naturally will allow more water to recharge into the ground to maintain the balance (river depletion). With natural balancing and the need to maintain downstream target quantities, the seasonal reservoir releases remain the same as under existing conditions. No net decrease in seasonal water use has occurred. Thus, no water is available for reallocation out of basin.

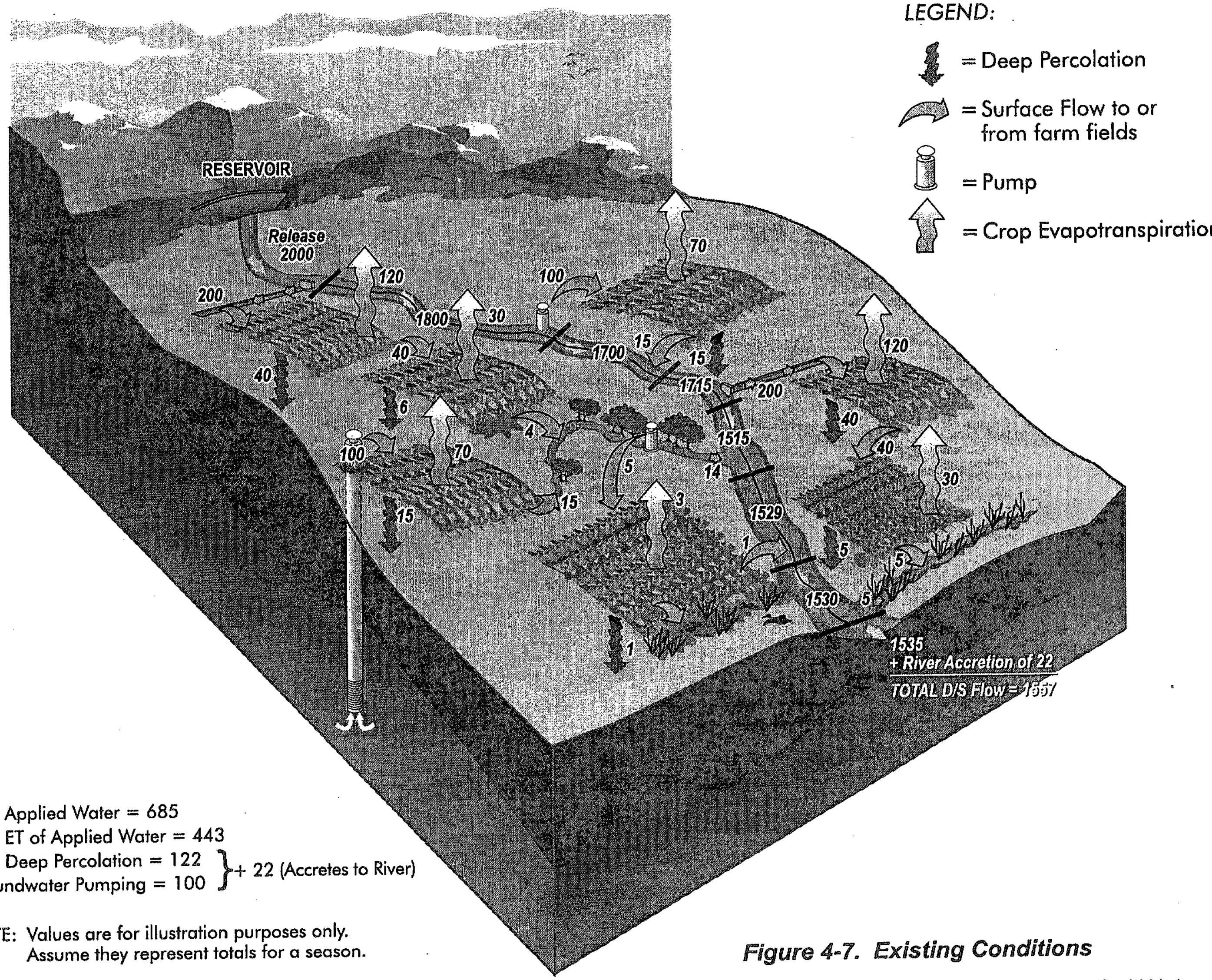
What does change is the seasonal management of water. For example, the seasonal quantity of water instream is higher in Figure 4-8 than under existing conditions, and surface return flows as well as direct stream diversions have been reduced. Indirect use has been changed to manageable, direct use.

The focus should be placed on the benefit from each unit of water, not on the unit of water itself. Changing to more manageable direct use can provide benefits desired by CALFED.

When comparing the two figures, the reduced diversions can reduce entrainment of aquatic species; reduced return flows can result in better in-stream water quality, although reduced return flows also may adversely affect drainage habitat. In addition, the increased in-stream flows can be re-regulated and released from reservoirs to correspond to fishery or other aquatic habitat needs (for example, fish attraction or out-migration flows) rather than for irrigation demands. This is not a water supply that can be reallocated out-of-basin, however.

These important benefits can be gained through efficiency improvements with no adverse impact on local users. However, local users may not be able to justify the cost of implementing efficiency measures when compared to the local benefit they may experience. Thus, outside assistance may be necessary to help realize the more regional or global benefits from improved local water use management and efficiency.

A number of different scenarios other than what is shown on Figure 4-8 could be developed to show how hydrologic elements are interconnected. For example, instead of increased groundwater pumping, a new surface water link could be directly routed to the fields from the river or from an existing canal diversion. This link may help groundwater levels remain high and reduce river recharge but would increase total diversions. Or, a new diversion could be constructed downstream and water pumped back upslope to each of the fields, with existing river diversions abandoned. This may reduce diversion impacts from a particular sensitive reach of the stream but would not change total diversions. Each of these scenarios would create different benefits and impacts. For example, pumping water back upslope would require more energy compared to using a gravity-based system. The array of possibilities underscores the importance to analyze each opportunity individually. What works well in one location may be detrimental in another.

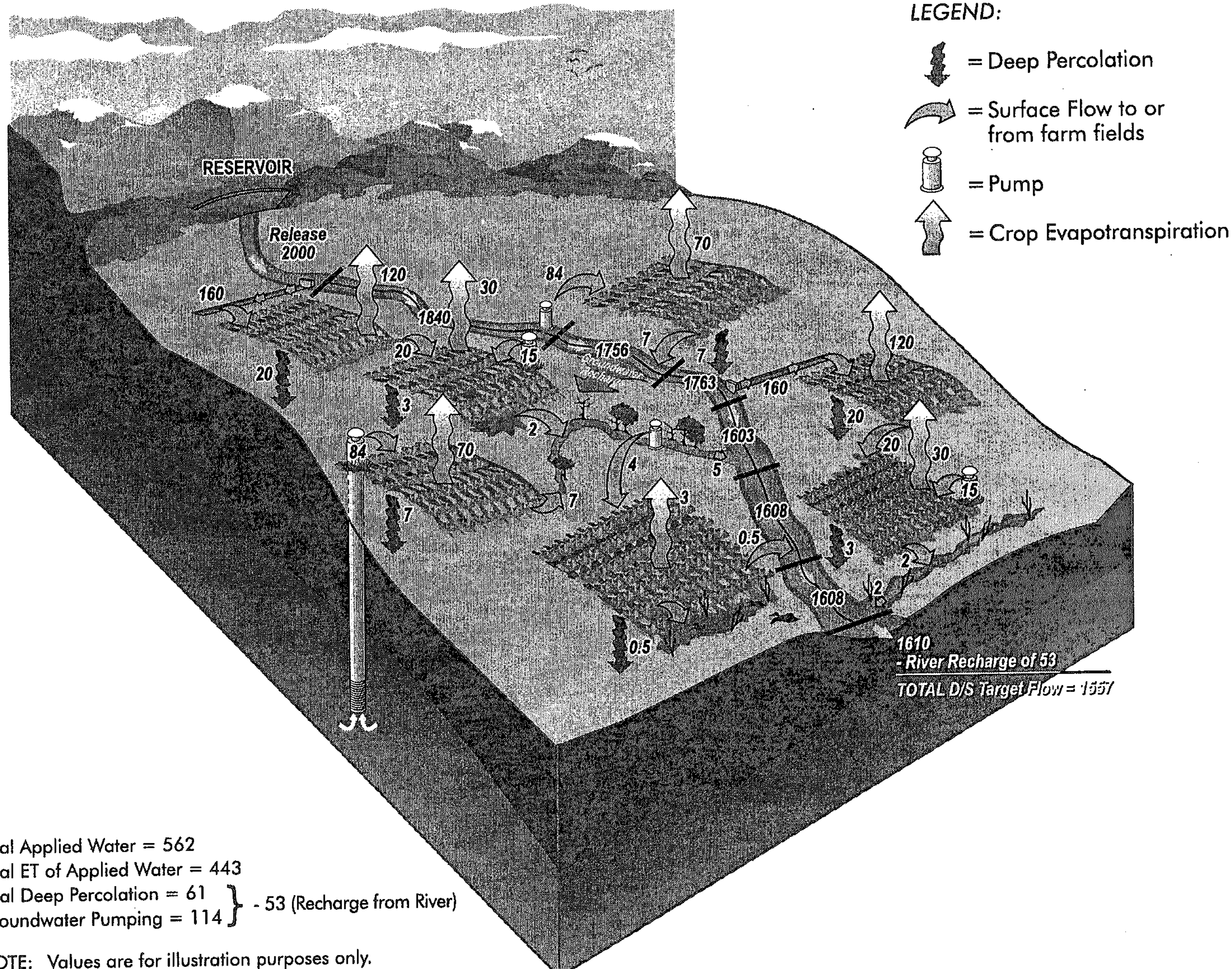


Total Applied Water = 685
Total ET of Applied Water = 443
Total Deep Percolation = 122 } + 22 (Accretes to River)
Groundwater Pumping = 100

NOTE: Values are for illustration purposes only. Assume they represent totals for a season.

Figure 4-7. Existing Conditions

Showing Interaction Between Applied Water, Beneficial Uses, Reuse, Groundwater, River Flows, and Downstream Target Flow.



Total Applied Water = 562
Total ET of Applied Water = 443
Total Deep Percolation = 61
Groundwater Pumping = 114 } - 53 (Recharge from River)

NOTE: Values are for illustration purposes only. Assume they represent totals for a season.

Figure 4-8. Change from Figure 4.7 Resulting from On-Farm Efficiency Improvements

4.6 ASSESSING BENEFITS FROM A BASIN-WIDE VIEW

It is important to note that in some instances water associated with irrecoverable losses provides a benefit and conservation of the losses could be detrimental. For example, agricultural drainage flow in the Imperial Valley currently flows to the Salton Sea. As stated above, these flows are considered irrecoverable losses because of their unavoidable degraded quality—in this case, as a result of leaching salts from the soil profile. However, these flows serve an important role in providing necessary dilution water for toxic drainage inflow from other sources, such as the New River, flowing to the Salton Sea from Mexico. In addition, they provide relatively fresh water to help maintain lake salinity and elevation levels.

Another example of irrecoverable losses providing a benefit is the Salinas Valley, where sea water intrusion into inland areas is an ongoing battle. The result is contamination of groundwater and associated wells with salty ocean water. Deep percolation resulting from inefficiencies helps maintain high groundwater levels that act to hold back the intrusion of sea water.

All aspects of a basin's hydrology should be considered as part of on-farm and district-level improvements. Analysis should be undertaken using basin-wide approaches that look for net benefits. These efforts will be assisted through the CALFED actions outlined in Section 2.